DEVELOPMENT OF COMPACT DUAL-BAND MONOPOLE ANTENNA FOR LTE APPLICATION

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DEDICATION

I would like to thank my parents **SATTAR RAHEEM** and **AMAL KAREEM** for giving me ethical support while I were doing this project. They always guided me to make sure I could finish my project on time and complete it successfully.

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ABSTRACT

Antenna plays an important role to radiate E fields and receive the E fields to induce the voltage at the input terminal of the receiver. Several antenna types are developed for wireless communication systems. Generally, it can be divided into two. One is elemental antenna and second one is radiated element antenna. Planar antenna is now a concern in many modern communication to reduce the design size. With a patch antenna, the device outlook will not have physical antenna but a build in antenna. In other words, a compact meander monopole antenna is design on FR4 substrate and moisturized for LTE communication system. This research project is about the miniaturized monopole antenna design, which has operating frequencies of 2.1 GHz and 3.5 for LTE mid-bands and high-bands communication systems. The proposed mender line radiation element is miniaturized the antenna size of $20\times13\times1.6$ mm^3. The designed monopole patch antenna achieves S_{11} parameters below -25 dB with gain around 2.2 dBi. The VSWR is 1.07 dB and the overall impedance simulation to optimize the results. After simulation, the antenna is fabricated and does the final testing in comparison with simulation results. The measurement observed very good agreement with the simulation outcomes.

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LIST OF SYMBOLS AND ABBREVIATIONS

C	-	Capacitance.
G	-	Gain
E	-	Electric Field
ϵ_r	-	Dielectric Permittivity.
ϵ_o	-	Permittivity of Free space
λ_g	-	Wavelength
Z_O	-	Characteristic Impedance
ϵ_{eff}	-	Effective Dielectric Constant
f_o	-	Resonant Frequency
c	-	Speed of Light
CST	-	Computer Simulation Technology
BW	-	Beam Width
PL	-	Path Loss
HFSS	-	High Frequency Structure Simulator
VSWR	-	Voltage Standing Wave Ratio
WI	-	Wireless Insite
WLAN	-	Wireless Local Area Network
WPT	-	Wireless Power Transfer
RF	-	Radio Frequency
AR	-	Axial Ratio
EM	-	Electromagnetic

CHAPTER 1

INTRODUCTION

1.1 Background

The antennas has been terribly essential devices for communications because it' is used as transmitter and receiver. Nowadays Communications devices like mobile phones becomes terribly skinny and smarter, to support many applications and need higher information measure wherever the micro-strip antennas square-measure the higher selection compared to standard antenna. To perform this operations, the micro-strip, antenna ought to give broad information measure at the compactly size. The fast evolution has come to the fore as associate advancements in the hand-held mobile devices and additionally the appearance, of the devices should be enticing with, little in dimensions. associate antenna will be delineate as tool, that transform the magnetism, wave in associate asocial, antenna to divergent in limitless medium.

In the past, mobile systems, were' established, to control for second generation systems, Cellular' System, digital, Personals Communication, services and world System for Mobile networks. Recently, several mobile communications, system apply many frequencies, band like GSM ,900-1800-1900 bands (890, 960 rate and 1710,1990MHz) Universal, Mobile Telecommunications Systems and UMTS third generation growth bands (1900-2200MHz and 2500-2700MHz) and Wi-Fi Wireless native space Network (WLAN) bands (2400,2500 rate and 5100,5800 MHz). Typically; one antenna cannot work in any respect of those frequency, band; as result multiband and broadband antenna square-measure essential, to produce multi-functional processes, for mobile, communications.

Resents trend in multiband antenna styles using in mobile, devices will be classified to 3 kinds: monopoles antennas, slot - type antennas and flat inverted-F antennas. Resonant achieve through completely various slots of assorted geometrics cuts on to the radiator and ground plane. The antenna in forthcoming should get the ability to haven't solely multiband operation, however additionally wide bandwidth, straightforward structure, compact sizes' and therefore the ability to simply structure with RF circuit, to realize these needs monopole antenna, is projected.

Low profile monopole antennas Offers low cost, simple, high width and broadband width [1]. Compact antennas that support multiple standards simultaneously wirelessly have been an interesting topic for industry and academia. The demand for small wireless devices has increased dramatically. Powerful multichannel and broadband antennas are indispensable for advanced radio systems. Future antennas must have a bandwidth that can be easily integrated into broadband frequency, simple design, compact registration and RF frequency. Fulfilling these requirements is a very difficult task.

The only monopole antenna with attractive advantages: low weight, low cost and high bandwidth is one of the favorite technologies that meet these requirements for the compact antenna, which supports many parameters simultaneously, as the wireless antenna device is interesting [2]. Research was industrial and academic research. The size of small wireless devices has increased dramatically with devices that operate at different levels. Compact antennas, multiband and broadband operating systems, as well as future wireless systems are needed. In the future, antennas should not only enable multiband modes, but also allow easy integration with broadband, simple format, compact dimensions, and high frequency circuits. It is too difficult to meet this requirement. With its attractive advantages, a monopole antenna such as light weight, low cost and detailed bandwidth is one of the most popular technologies to meet these needs [3].

The multiband antenna have are used high interest, in present decades for solutions to multimode communication designs. Due to less charge and simplicity of procedure, monopole antennas are commont can dilates for these applications. The currently, popular designs suitable for wireless local area network (WLAN) operations in the 2.4 GHz (2.4-2.484 GHz) and 5.2/5.8 GHz (5.15-5.35 GHz) (5.725-5.825 GHz) band have been reported.

The monopoly antenna may be a category of an Omni-directional antenna consisting, of straights, rod formed conductors, usually mounted sheer over some types of semi-conductive surfaces referred to as ground plane. Monopole antenna will be of an assorted geometric and square measure the use in several appliances, like cellular telephones and automotive radios, and in broadcasting. A typically, feeds line for the monopoly antenna may be a coax with its inner conductors, connected through a hole to the bottom plane, to the vertical, monopole components and its outer conductor connect, by suggests that of a rim to the bottom plane. Usually the inner conductor's diameter a capable a monopole element's diameter and therefore the out conductor's, diameter a capable a bottom plane hole diameters. monopole antenna, have Omnidirectional, radiation diagram characteristic, square measure terribly appropriate for indoor applications, like plane, shopping mall, hospital, etc. significantly, their radial asymmetry on or close to a radio horizon make the appropriate for communications, system wherever most operational, vary usually depend, on a directivity on radio horizon [4].

Wi MAX may be a Wireless communication, normal design to produce the high speed information rates. It's capability to deliver high-speed web access and phone services to subscribers allows new operators to contend during a range of various markets. In urban areas already coated by telephone line (Digital Subscriber Line) and high-speed wireless web access, WiMAX permits new entrants within the telecommunication sector to contend with established fixed-line and wireless operators. The hyperbolic competition may end up in cheaper broadband web access and telephone services for subscribers. In rural areas with restricted access to telephone line or cable web, WiMAX networks offers cost-efficient web access and will additionally encourage the UMTS / HSDPA, (High Speed Downlink Packet [5].

These include satellite navigation systems, cellular systems, wireless LAN and a mix of these systems. one of the most popular antennas for mobile communications is a uniplaner antenna characterize, by uniplaner antenna that are suitable for 50 ohms, which is unbalanced. This eliminates the need, and the bandwidth may be limit. The simplest member of the family is the wave of the Monopole quarter above ground level. the resistor that can be achieved depends on the quadrilateral mono wave antenna on the radius of the cylindrical heel, and increases with increased radius. this is true until the point at which the radius of the beam from the probe, to the cylinder element becomes sudden.

This transition is often used in broadband elements, such as bipolar dipole diodes and conical monopoly. BW (10 dB return loss) is usually the length of 20% and the radius factor is 25% and 16%, respectively, in the frequency band from 1-

6GHz. The simplest technique, at a lower cost, is the cylindrical heel change of the traditional monopole with a flat element, resulting in a flat monopoly. Mink and Gundelach, who referred to them as two different types of cylindrical and conical rectangular plates, first described it as stable in a textbook in 1968. Dubost and Zissler described more detail in 1976. They observed the broad impedance characteristics of this antenna. Later, a number of different shapes were considered for this category of flat monopole antennas. Agrawal, who proposed a formula for predicting, the frequency corresponding to the bottom margin of these antennas, also studied circular and oval monopoles in 1998 [6].

In the development of mobile antennas, the antenna has become an integral part of mobile devices. To achieve this, the mobile mobile antenna needs to be small, flexible and efficient. Rectangular micro-strips are one of the most commonly used antennas due to their low cost, low profile, and versatile radiation formats. The main errors of the antenna are narrow bandwidth and low noise. Many applications, such as remote sensing, biodiesel, cellular and satellite connectivity, require high bandwidth. At the same time, broadband research was conducted to promote bandwidth and many technologies.

Modified forms of the radioactive element include a conventional induction method for partially subdividing the groundwater, the concentration of the capacitor between the plate and the ground, the chip resistance, and the wafer position between the smooth and the ground. However, the antenna design is not very complex or practical for the frequency of the GHz because the difficulty of developing broadband or multi-band functionality for conventional and compact antennas is in the complexity and structure of the antenna and the operating frequencies increase. As mentioned above, the antenna project is a rectangular, oblong microscope, but in previous studies it is too high how often the error calculates the chances of the operational model [7].

Contemporary wireless communication must automatically manage and manage various operations. This is a major problem in the simultaneous transmission of audio and video information to antenna designers to meet the bandwidth requirements. To satisfy the needs of all its customers, the result is the configuration and labeling of the system. Antenna sets play an important role in a good and effective communication system. It is used to receive transmissions and wireless data [8].

As being complete on a ground plane, it's additionally referred, to as ground plane antenna. Monopolis antenna signals and multidirectional radiation are ideal for local consumption such as aircraft, shopping malls and hospitals. In particular, the mentioned address or radio station makes it adaptable to radio based communication systems to achieve maximum directivity [9].

The bandwidth of the suggested antenna is extended sufficiently for almost all applications of mobile telecommunication systems, GSM/UMTS/ LTE, involving LTE mid-band 34 (2.0–2.1 GHz) and high-band 42 (3.4–3.6 GHz). The distinctive feature, of a suggested antenna is that not only four loop antenna modes [10]. Monopole type antennas ideally give omnidirectional patterns [11].

1.2 Problem Statement

The range of the operation bandwidth is reduced as its physical size is reduced, so many standard monopole antennas have been developed to miniaturize the material size. The monopole antennas have a small relative size while realizing the mid-band resonance frequency (2.1 GHz) of an LTE system needs to design a large antenna size. The traditional techniques with antennas reduce the physical length of the antenna, it has been difficult to manufacture these antennas through the strict tolerance priorities in their work and continue to have a detrimental effect on increasing their diameter. Therefore, the total size of the antenna must be increased. It is difficult for traditional cosmic orbit antennas to be small in size, at the same time a low cost feature, high antenna gain, good radiation patterns and wide operating widths.

1.3 Objectives of the Study

To fulfil the requirement of broadband wireless, the antenna design must be compact with multi-operational characteristics. This research has identified the following objectives for study and development of broadband antennas

(i) To design and develop a dual-band planar monopole antenna for LTE applications 2.1 GHz and 3.5 GHz operating frequencies.

(ii) To develop antenna with respect to less than -10 dB impedance bandwidth, VSWR > 2, gain about 1 dBi, and radiation pattern.

(iii) To evaluate and validate the design in laboratory and field test environment, mainly focusing on the antenna needs of small size, less charge, high level of gain, and good radiation models.

1.4 Scope of Project

1- There are different kinds of antennas obtainable in recent situation. However, in this research, only monopole type is taken into account. The suggested antenna must be doing in required values of frequency of LTE communication systems.

2- If the single antenna can be adjusted to more than single frequency, it is taken into account as multiband antenna. The proposed monopole antenna operated in mid-bands and high-bands of the LTE systems.

3- With a small size and easy fabrication by printing on an FR4 substrate, the suggested antenna could be used in wireless mobile solutions.

4- The CST software is applied in this research to create and develop the suggested antenna shall be applied to improve the suggested design.

5- The proposed design fabricated on FR4 substrate by using etching method, then it tested by using the available network analyzer.

1.5 Project outline

The project is organized into five chapters. Whereas Chapter one is discussed the background on the wireless communication standard frequencies and antenna .designMoreover, the problem statement is highlighted and followed by the objectives then the research scope.

In Chapter two, the overview of the LTE wireless communication system is explained. In addition, several antenna types are illustrated. After that, a review n the monopole antennas is discussed thoroughly. Lastly, the chapter is summarized in the summary section.

In chapter three, the methodology of implementing this work is explained. The antenna design, the simulation, fabrication, and measurement process are explained.

In Chapter four, both of the simulation and results are validated. The results are further analysed.

In chapter five, the conclusion of this work is addressed and some future works are .recommended too

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses about the literature review of the project. It will be focused on the information that have been collected from a journal that related to the studies of monopole antenna**.**

2.2 Long Term Evolution (LTE)

The LTE is a state-of-the-art IP wireless broadband standard designed to effectively support packet-based communication and was developed by 3GPP to be a 4G standard .the LTE consists of two main components: E-UTRAN and EPC. The E-UTRAN consists of eNB transceiver stations, which are different from those of the second generation 3G and 3G stations as they perform more complex operations than their predecessor User data, processing and conversion and broadcast some messages to control, and the EPC is the heart of the network and the headquarters of management and control and the center of communication with other networks, and the most important differences between the networks and the second generation 2G and 3G that in the 3G and 2G are needed two separate networks, -switched and which are used for voice transmission and Packet-switched which It is used for data transmission for high speed.

The LTE specification and performance, using modern technologies such as MIMO and OFDM, greatly increased network performance. Downlink speeds range from 100 to 326 Mbps depending on the number of antennas used in the transmitter and the receiver as well as the modulation method.

The uplink speeds range from 50 to 86 Mbps. The quality of the data used are all packets switched data whether for voice, video or any type of data. The bandwidth used is from 1.25 to 20 MHz. The LTE network for these specifications makes it very convenient for high-speed data and media, and is also suitable for all IP-based applications such as IPTV, Voice over IP and other built-in services On IP.
It is worth mentioning that another LTE competitor, from which several versions have been released, the latest versions of which are included in the 4G standards, WiMAX (802.16 by IEEE), is a very strong LTE competitor on the one hand, But most carriers have adopted the LTE standard for its relatively easy availability of infrastructure, because it is an extension and development of the GSM standard currently used, while WiMAX is a widely developed version of WI-FI.Is the trademarked project name of a high performance air interface for cellular mobile telephony.

It is a project of the 3rd Generation Partnership Project (3GPP), operating under a named trademarked by one of the associations within the partnership, the European Telecommunications Standards Institute The recent increase of mobile data usage and emergence of new applications such as mobile TV, MMOG (Multimedia Online Gaming) and streaming contents have motivated the use of (LTE) standards.
LTE is the latest in the mobile network technology that ensures competitive edge over its existing standards: GSM/EDGE and UMTS / HSxPA [9], where HSPA means High Speed Packet Access is a collection of two mobile telephony protocols, High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA), that extends and improves the performance of existing WCDMA protocols.

LTE, whose radio access is called "Evolved UMTS Terrestrial Radio Access Network (E-UTRAN)", is expected to substantially improve end-user throughputs, sector capacity and reduce user plane latency, bringing significantly improved user experience 9 with full mobility. With the emergence of Internet Protocol (IP) for carrying all types of traffic, LTE is scheduled to provide support for IP-based traffic with end-to-end Quality of service (QoS). Voice traffic will be supported mainly as Voice over IP (VoIP) enabling better integration with other multimedia services.

Initial deployments of LTE are expected by 2010 and commercial availability on a larger scale are expected 1-2 years later [12].

LTE uses Evolved Packet Core (EPC) network architecture to support the EUTRAN which reduces the number of network elements, simplifies functionality, improves redundancy, but most importantly allows for connections and hand-over to other fixed line and wireless access technologies in a flawless manner. The aggressive performance of LTE rely on physical layer technologies, such as, Orthogonal Frequency Division Multiplexing (OFDM), Multiple-Input Multiple-Output (MIMO) systems and Smart Antennas to achieve these targets.

The main task of LTE is to reduce the complexity of the system and user devices to reduce data transmission and latency. Small and compatible antennas are important for communication devices. Broadcast antennas are always used on mobile devices, but this is a normal challenge. Recently, the winding method has been used to design small but broadband antennas, in which the size of the radiation element decreases in proportion to the number of coefficients. Because of walnut antennas (MLA), they connect directly to mobile phones. In addition, it significantly increases productivity and battery life from mobile phones in other markets. In addition, engineers can use MLA technology to develop broadband antennas that operate at multiple frequencies and in many different ways.

2.3 Antennas

There are many functions or applications that are used for the use of standard LTEs for each lainalinklink and linklink for the user equipment and eNB (to evolved NodeB) with border limits and the maximum limit of the lower alarms and the luggage line for each group.

2.3.1 Micro-strip Patch Antenna

In the simplest form, the micro-strip antenna is composed of a dielectric substrates placed between two conductive surfaces: the antenna plane and the mass plane. Portable micro patch antenna as illustrated in Fig 2.1 below.

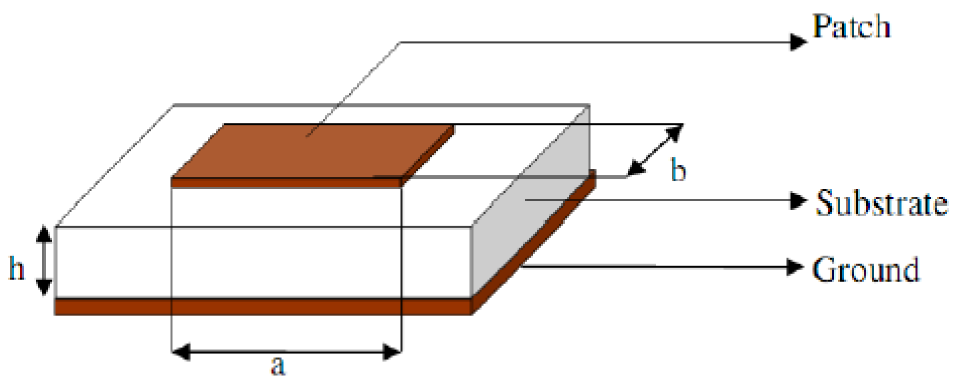

Figure 2.1: Basic rectangular micro-strip patch antenna construction

The antenna radiates the micro-strip package mainly due to the field edge between the edge of the patch and the baseplate. Since the EM field is scattered in the substrate and in free space, a near-state TEM is generated. The length and width of the patch are marked in the order (a) and (b). The thickness of the substrate is h. Often microtracking antennas are supplied with power. Micro-strip types are frequently feed applying; Micro-strip Line feed [13], Coaxial feed [14],
Proximity coupled [15] and Aperture coupled [14] techniques, each with their own advantages and disadvantages [16]. The substrate thickness is given by h.

Along with a number of advantages [17] micro-strip antennas also suffer from some disadvantages [13] [14] like narrow bandwidth, low degree of Gain, low value of efficiency, specious radiation and surface wave excitation. While spurious radiation and surface waves could be reduced by applying the right feed techniques and substrate thickness [13], the problems of major interest are poor bandwidth and low value of radiation efficiency. Micro-strip antennas essentially face Ohm losses and di-electric losses making it a high Q device [13].To accomplish larger gain and bandwidth we should surge substrate thickness but this may appear in waves of surface [14].

2.3.2 Helical antenna

A helical antenna is a specialized antenna that is considered to be a hybrid between a loop antenna and a dipole antenna. It consists of a conducting wire wound in the form of a helix. Helical antennas are usually mounted over a ground plane and the feedline is connected between the bottom of the helix and the ground plane.as show in finger2.2

Figure 2.2: Helical Antenna

The helical antenna could also be a hybrid of two easy radiating components, the dipole and loop antennas. A helix becomes a linear antenna once its diameter approaches zero or pitch angle goes to 90º. On the other hand, a helix of mounted diameter could also be seen as a loop antenna once the spacing between the turns vanishes.

Coiled antennas square measure wide used as easy and wise radiators, over the last five decades attributable to their exceptional and distinctive properties. The rigorous analysis of a helix is very tough. Therefore, radiation properties of the helix, like gain, far-field pattern, axial relation, and input electrical resistance square measure investigated victimization experimental ways that, approximate analytical techniques, and numerical analyses [18]. As show in figure 2.3

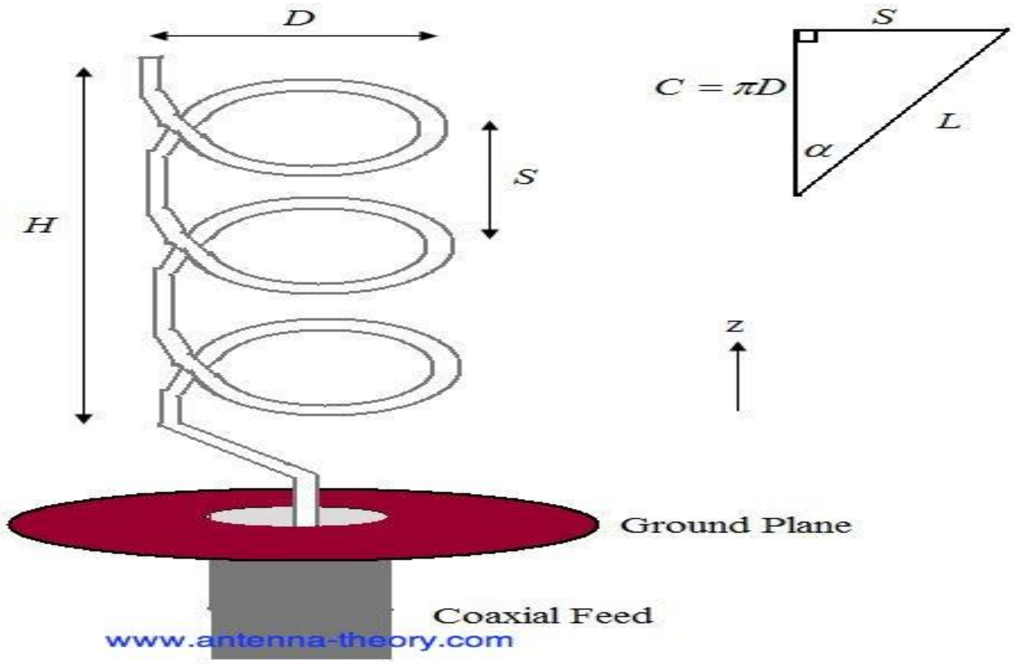

Figure 2.3: Helical antenna system

2.3.3 Meander Line Antenna

The meander antenna is a type of printable antenna that is smaller when embedding the cable structure in the substrate. MLA dielectric technology was developed by BAE SYSTEMS (formerly Lockheed Martin Company) [19]. For information and electronic warfare systems (IEWS) require high-quality antennas for satellite and terrestrial communications.

Nowadays, these antennas are suitable for mobile applications. A wireless data network for laptops, PC cards and access points is considered. Basically, the serpentine strip antenna is a combination of strip and conventional cable. These benefits include easy configuration simplification, easy access to wireless devices, low cost, and low SAR absorption. When the SAR radio frequency (RF) is exposed to electromagnetic fields, energy is the measure of the volume absorbed by the body. It is defined as the effect of absorption with the mass of tissue and has combined a single watt, mass.

The radiation element in the Menderes antenna (also called the shaft line antenna) consists of a hermetic linear line formed by a series of bends that are rectangularly compensated, as shown in Figure 2.4. In this case, the main element is the four rectangular corners and the radiation is mainly derived from the breakdown of the structure. Corners in the right angle can be expensive or compensated to reduce sensitivity to rectangular cutting when adjusting the impedance. At each wavelength, there are more than four changes in the direction of the current change and the wavelength in the project. Depending on the size of the Menderes line antenna, the band radius is added to obtain the desired polarization.

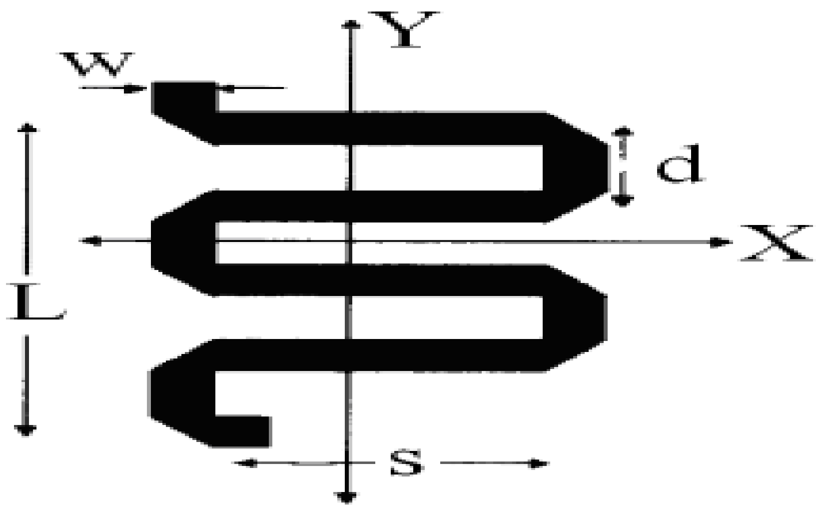

Figure 2.4: The Fundamental Section of the Meander Line Antenna

2.3.4 Monopole Antenna

A small intrinsic antenna is provided for the two abbreviated monopolies with a loop antenna. The recommended antenna is 8-pin LTE / GSM / UMTS with a compact flat flat structure of 40 x 15 mm 2 (600 mm 2). The wheel-mounted monopole and the short-coupled connector provide an elastic resonance path at the top of the antenna to create a resonance profile for the bottom of the antenna.

Then the lines containing two stocks are combined with a ring-sized antenna, and two lines are connected to a monopoly controlled and placed on a short circle with a short circle on a pair of aircraft. That is, the two-ply short wave tape has ring-sized antennas monopoles and an integrated configuration.

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